THE TRIDENT II MISSILE TEST PROGRAM:

IMPLICATIONS FOR ARMS CONTROL

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PREFACE

The Navy is conducting flight tests of the Trident II submarine-launched ballistic missile. Some in the Congress have argued that certain of these tests--those involving the twelve-warhead version of the missile--could complicate future arms negotiations. Should the Congress limit tests of the twelve-warhead version? If so, how should they be limited? These issues merit prompt attention since the first test of the twelve-warhead version with a full complement of warheads is scheduled to occur within the next few weeks.

To aid the Congress in exploring the issue, this analysis by the Congressional Budget Office (CBO) examines the advantages and disadvantages of two options in the event the tests continue and one option in the event they are canceled. The study was requested by the Ranking Minority Member of the Senate Committee on Armed Services. In accordance with CBO's mandate to provide objective analysis, the study makes no recommendations.

Jeffrey A. Merkley of CBO's National Security Division prepared the study, under the general supervision of Robert F. Hale and John D. Mayer, Jr. The author also gratefully acknowledges the contributions of Marvin M. Smith and Mark Dayton of CBO. Francis S. Pierce edited the manuscript, and Rebecca J. Kees prepared it for publication.

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November 1987

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SUMMARY

The United States has several types of strategic nuclear weapons including bombers, sea-launched cruise missiles, intercontinental ballistic missiles (ICBMs), and submarine-launched ballistic missiles. To improve its submarine-launched ballistic missiles, the United States is developing the more accurate and more powerful Trident II missile to replace the current Trident I missile.

The flight-test program for the Trident II missile is the subject of a controversy: Should flight tests of one version of the missile--a version configured to carry twelve warheads--continue even if those tests might complicate negotiation of an agreement reducing strategic nuclear warheads?

The controversy has arisen from efforts to achieve the best results in two separate areas: weapon design and arms control. In designing and developing the Trident II, the Navy and the Administration have striven to obtain flexibility and to utilize the large carrying capacity or "payload" of the missile. Accordingly, the Navy has planned to develop and deploy two versions of the missile:

- An eight-warhead version with larger warheads that are effective against facilities that have been highly hardened against nuclear attacks (such as newer Soviet ICBM silos and command centers buried deep underground); and

- A twelve-warhead version with smaller warheads that are effective against moderately hardened facilities (such as older Soviet ICBM silos, munitions bunkers, and most command centers).

Flight-testing both versions of the Trident II would, however, potentially complicate one of the major tasks in negotiating an agreement reducing strategic warheads: determining how many warheads to credit to each type of strategic ballistic missile. Analysis of several strategies for crediting warheads to the Trident II suggests that, if further flight tests of the twelve-warhead version go forward, either the United States or the Soviet Union could feel disadvantaged. That would not preclude an arms agreement but could make negotiations more difficult. Despite testing already done to date, limiting further tests of the twelve-warhead version might avoid these complications.

PROCEED WITH TESTS OF TWELVE-WARHEAD VERSION: ADVANTAGES AND DISADVANTAGES

If flight tests of the twelve-warhead version of the Trident II proceed, the United States would have two basic strategies for crediting warheads to the Trident II under a limit on strategic warheads. The first would credit the Trident II with eight warheads while the second would credit it with twelve warheads.

One Strategy: Seek to Credit Trident II with Eight Warheads

Under this strategy, the United States would continue to test and deploy a mix of both versions of the Trident II; in arms negotiations, however, the United States would offer to cancel deployment of the twelve-warhead version but insist on crediting the Trident II with only eight warheads.

This strategy offers several advantages to the United States. Since the strategy imposes no limits on flight tests, it would not cause any delays in the development program for the Trident II. Also, in the absence of an agreement limiting strategic nuclear weapons, the United States would be able to deploy both versions of the Trident II, utilizing the large payload of the missile and maintaining the flexibility inherent in deploying both larger and smaller warheads. Furthermore, in the event of an agreement, crediting the Trident II with only eight warheads would deploy the permitted number of warheads on a larger number of missiles and hence a larger number of submarines, enhancing their survivability and improving U.S. confidence in deterrence.

The major drawback to this strategy is that the Soviet Union would probably strongly resist efforts to credit the Trident II with only eight warheads after a twelve-warhead version had been developed and fully tested. In an agreement reducing strategic weapons, each side would want to prevent the other from having the capability to deploy extra warheads surreptitiously or to "break out" of the agreement--that is, to withdraw from the treaty suddenly and increase quickly the number of warheads on deployed missiles. Under this U.S. strategy, however, the United States would have these capabilities: the Trident II would be credited with only eight warheads while having a fully developed capability to carry twelve warheads. Thus, the Soviet Union would almost certainly argue that the Trident II should be credited with twelve warheads.

The United States might eventually persuade the Soviet Union to credit the Trident II with only eight warheads. But the Soviet Union might

seek other concessions, adding to the complexity of negotiations that are already difficult.

Another Strategy: Agree to Credit the Trident II with Twelve Warheads

If the United States proceeds to develop and flight-test the twelve-warhead version of the Trident II as well as the eight-warhead version, another strategy would have the United States deploy both versions but agree to credit the Trident II with twelve warheads under any future agreement limiting strategic nuclear weapons.

This strategy has some of the same advantages as the previous approach, leaving the current development program for the Trident II undisturbed and enabling the United States, in the absence of an agreement, to maintain flexibility by deploying both versions of the missile. In addition, since this strategy would credit the Trident II with the maximum number of warheads for which it was designed, the strategy should raise no objections from the Soviet Union.

Crediting the Trident II with twelve warheads would, however, lead to disadvantages for the United States. If the Trident II was credited with twelve rather than eight warheads, the United States could deploy fewer missiles under a sublimit on ballistic missile warheads. Under lower sublimits like the one currently proposed by the United States, deploying these missiles on Trident submarines could result in a fleet of missile-carrying submarines only one-fourth to one-third of the current number. The United States would therefore have to choose between the risk that this smaller fleet would be more vulnerable (the Soviet Union might devote more resources to attacking it through conventional means or through sabotage) and the cost of increasing the size of the fleet either by reducing the number of missiles each Trident can carry or by deploying a new class of smaller missile-carrying submarines.

Moreover, crediting the Trident II with twelve warheads would present a dilemma. On the one hand, the United States could choose to deploy only the twelve-warhead version of the Trident II missile. In this case, the number of deployed warheads would be equivalent to the number credited to the United States, but the United States would not have the capability against very hard facilities provided by the eight-warhead version. Establishing that capability has been a major objective of this Administration.

On the other hand, the United States could deploy both versions of the missile, retaining the capability of the eight-warhead version. But since

each eight-warhead missile would be counted as carrying twelve warheads, the United States would be credited with more warheads than are actually deployed. Under a range of plausible assumptions about the agreement now being negotiated in Geneva, the United States could have roughly 400 to 900 of these "phantom" warheads. Analysis in this study shows that these phantom warheads would diminish the capability of U.S. ballistic missile forces to destroy various notional target sets, though not by more than 10 percentage points following a large Soviet attack. This change might not be great enough to diminish deterrence. Indeed, the major effect of the phantom warheads might be political, since they could cause the United States to have fewer deployed ballistic missile warheads than the Soviet Union under ostensibly equal limits.

Despite these problems, the United States might eventually accept this strategy of crediting the Trident II with twelve warheads just as the Soviet Union might accept the previous strategy. U.S. acceptance, however, could be contingent on concessions from the Soviet Union or on changes in U.S. forces that minimize the problems of submarine survivability and phantom warheads, making negotiation of a treaty more difficult and time consuming.

ADVANTAGES AND DISADVANTAGES OF LIMITS ON TESTING

Ending development of the twelve-warhead version of the Trident II missile by canceling flight tests of that version might avoid the negotiating complications noted above. Such an approach would develop and deploy only the eight-warhead version.

This approach would avoid complicating negotiations only if the Soviet Union concluded that the United States, by canceling flight tests of the twelve-warhead version, would not have confidence that the twelve-warhead verison would work as planned. The Soviet Union might not reach that conclusion. The United States has already conducted one test of the twelve-warhead version; a second test is imminent. Coupled with computer modeling, this might give the United States confidence that the twelve-warhead version would work and would certainly give the Soviet Union some grounds for crediting the Trident II with twelve warheads. On the other hand, the one or two tests represent only the initial step in a full development program. They were conducted with development missiles, not production missiles; they provided no opportunity to test modifications; and they were conducted approximately six to seven years before planned deployment. Thus, if further tests were canceled, there would be reasonable grounds for arguing that the United States had not established the capability

to deploy the twelve-warhead version with confidence and that it should be credited with only eight warheads.

This approach imposes only modest disadvantages. The second flight test of the twelve-warhead version, if it has not occurred, would have to be canceled, but that would delay completion of the 30-flight development program by at most a few months. Nor would this option preclude deploying smaller warheads--and therefore maintaining the flexibility provided by deploying two types of warheads--on the Trident II missile. The United States could decide at a later date to resume development of the twelve-warhead version; if that decision was made by 1990, it would not affect the current schedule for deploying that version. Alternatively, a modified version of the Trident II could be developed that would carry only eight of the smaller warheads, though this approach could increase costs.

HOW TO IMPOSE TEST LIMITS

If the Congress were to limit flight-testing of the twelve-warhead version of the Trident II, it would need to decide how to limit them. The discussion above assumed that all further testing of the twelve-warhead version would be canceled. It would also be possible to continue testing of the twelve-warhead version but only to test that version with eight or fewer warheads.

This approach, however, would offer less assurance of avoiding complications in arms negotiations since the tests, coupled with computer modeling, would probably enable the United States to deploy the twelve-warhead version with confidence that it would work as planned. Consequently, simply restricting tests of the twelve-warhead version to no more than eight warheads at any one time might not strengthen U.S. arguments for crediting the Trident II with only eight warheads.

FLIGHT TESTS AND ARMS CONTROL

The United States and the Soviet Union possess several types of nuclear weapons with which they can assault each other from great distances. These strategic nuclear weapons include bomber-delivered munitions (bombs, short-range attack missiles, and long-range cruise missiles); sea-launched cruise missiles; intercontinental ballistic missiles (ICBMs); and submarine-launched ballistic missiles (SLBMs). The United States is currently conducting flight tests of a new SLBM, the Trident II, to be carried aboard the Trident submarines.

The flight-test program for the Trident II missile is controversial: Should flight tests of a version of the missile designed to carry twelve warheads continue if those tests would complicate negotiation of a limit on strategic warheads? The Administration believes the tests should continue in order to preserve flexibility in the absence of an agreement. Some in the Congress argue that tests should be limited to avoid complicating arms negotiations. This paper addresses that issue.

BACKGROUND

Resolution of this issue requires understanding the Trident II missile and the interaction of arms control negotiations and missile tests.

The Trident II Missile

Currently the United States has two types of submarines carrying SLBMs. Poseidon submarines carry either the Poseidon or the Trident I missile. Trident submarines, eight of which are deployed, also carry the Trident I missile but are scheduled to be fitted with the new, more powerful Trident II missile. The United States will probably continue to retire the aging Poseidon submarines and build toward a force of approximately 20 Trident submarines all equipped with the Trident II missile. 1/

When used in a nuclear attack, a Trident II missile would be launched into space from a submarine. In space the post-boost vehicle, which is a

1. The Navy has not committed itself to a specific number of Trident submarines, but has used 20 Trident submarines as a planning figure for designing support facilities.

platform carried by the missile, would begin releasing reentry vehicles (RVs), which contain and protect a nuclear warhead during reentry through the atmosphere. The post-boost vehicle can send each RV to a different target by changing trajectory before releasing each RV.

The United States is reportedly designing two versions of the Trident II--one version designed to carry eight Mark-5 RVs and another designed to carry twelve Mark-4 RVs. 2/

- o Eight-warhead Mark-5 version: the post-boost vehicle has eight stations for Mark-5 RVs, which on deployed missiles would reportedly each contain a nuclear warhead with an explosive yield equivalent to the yield of about 400 to 500 kilotons (kt) of TNT. 3/

- o Twelve-warhead Mark-4 version: an adapter ring modifies the post-boost vehicle to establish twelve stations for Mark-4 RVs, which on deployed missiles would each contain a nuclear warhead with an explosive yield equivalent to about 100 kt of TNT. 4/

Both of these versions utilize the larger payload of the Trident II missile. Having two versions also increases the flexibility of the Trident II missile. The eight-warhead Mark-5 version can effectively attack facilities highly hardened against a nuclear attack (such as newer Soviet silos for ICBMs and very hard command centers) as well as softer targets. The twelve-warhead Mark-4 version can effectively attack a larger number of moderately hardened facilities (such as older Soviet missile silos, munitions bunkers, and most command centers) as well as softer targets. 5/ Figure 1 shows an estimate of the probability that a single Mark-5 or Mark-4 RV arriving in the target area would destroy targets of various hardness.

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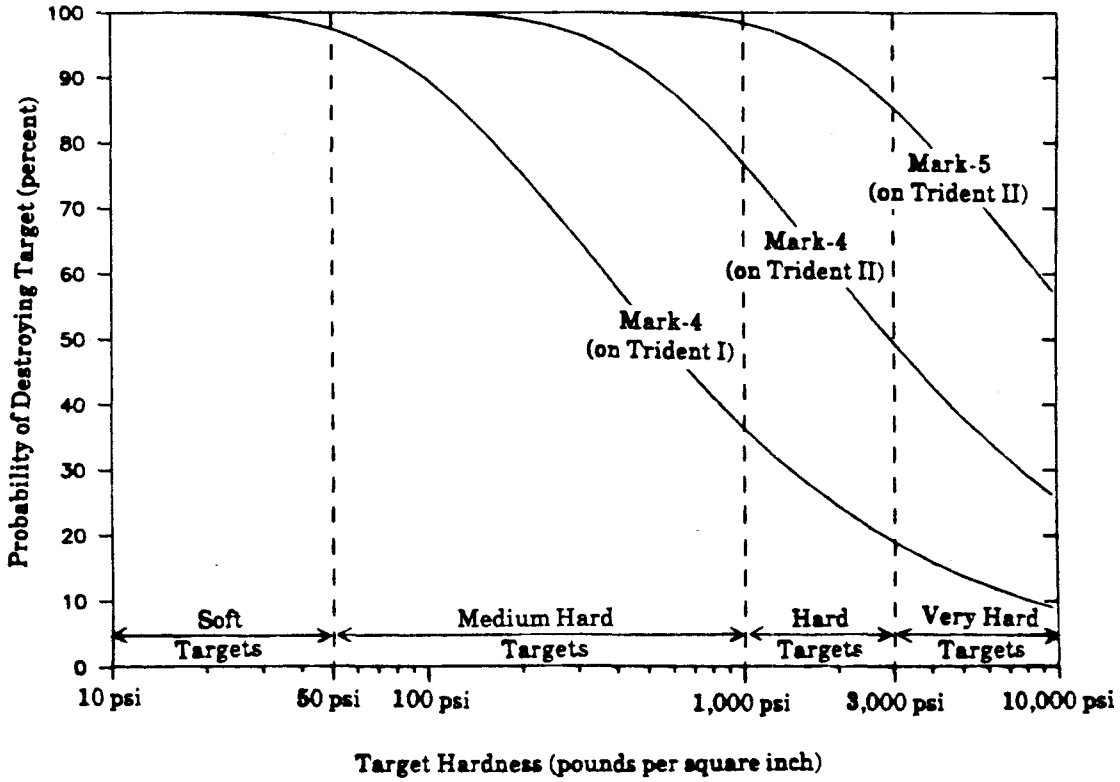
2. See Michael R. Gordon, in the *New York Times*, October 7, 1987, "U.S. Plans to Test Submarine Missile with 12 Warheads."

3. Press sources have stated that the yield for the warhead contained in the Mark-5 RV will be about 475 kilotons. See Thomas B. Cochran, William M. Arkin, and Milton M. Hoenig, *Nuclear Weapons Databook Volume 1: U.S. Nuclear Forces and Capabilities* (Cambridge, Massachusetts: Natural Resources Defense Council, Inc., 1984), p. 145.

4. See *Nuclear Weapons Databook Volume 1*, p. 142.

5. The 100 kt warhead carried in Mark-4 RVs and the 400-500 kt warhead carried in Mark-5 RVs are both much larger than the atomic bombs dropped on Hiroshima (12-15 kt) and Nagasaki (20-24 kt) during World War II. See *Nuclear Weapons Databook Volume 1*, p. 32.

FIGURE 1. CAPABILITY OF MARK-4 AND MARK-5 REENTRY VEHICLES AGAINST THE TARGET SPECTRUM



SOURCE: Calculations by Congressional Budget Office using a formula presented in Lynn Davis and Warner Schilling, "All You Ever Wanted To Know About MIRV and ICBM Calculations But Were Not Cleared to Ask," *Journal of Conflict Resolution*, vol. XVII, no. 2 (June 1973).

NOTES: This figure shows the probability that an arriving reentry vehicle (RV) will destroy a target of given hardness.

It is assumed that the Mark-5 RV contains a 475 kt warhead and that the Mark-4 contains a 100 kt warhead. It is assumed that the Trident II has an accuracy (measured in Circular Error Probable (CEP)) of 500 feet and that the Trident I has an accuracy of 900 feet. See Congressional Budget Office, *Trident II Missiles: Capability, Costs, and Alternatives* (July 1986), p. 10.

"Soft" targets include vehicles and buildings; "medium hard" targets include munitions bunkers, leadership bunkers, older Soviet ICBM silos, and most command and control centers; "hard" targets include ICBM silos of moderate hardness such as the silos for the U.S. Minuteman ICBMs; "very hard" targets include newer Soviet ICBM silos, command centers buried deep underground, and tunnels designed to protect Soviet missile-carrying submarines.

The Administration is committed to developing and deploying both versions of the missile. The eight-warhead version accomplishes the Administration's goal of increasing U.S. ability to destroy highly hardened targets in the Soviet Union. The twelve-warhead version constitutes a cost-effective method of maximizing the number of soft and moderately hardened targets that the missile can destroy, since Mark-4 RVs will simply be transferred from Trident I missiles. Such soft and moderately hardened targets constitute the overwhelming majority of the potential target base. 6/

The Administration has thus planned to flight-test both versions of the Trident II missile. Seven of 30 planned flight tests in the development program for the Trident II have occurred. Of the seven tests, only number six has been of the twelve-warhead version. Further tests of the twelve-warhead version are planned, however, including the eighth flight test (which is scheduled to be launched this month and would be the first to utilize all twelve stations on the post-boost vehicle) and additional flights scheduled for 1988. 7/

Flight Tests and Arms Control

At the Strategic Arms Reduction Talks (START) in Geneva, the United States and the Soviet Union are attempting to negotiate a limit on strategic nuclear warheads. 8/ The negotiation has many difficult aspects. Methods must be devised for counting warheads deployed on different strategic weapons, including:

- Short-range attack missiles (SRAMs) and bombs carried on strategic bombers that fly into enemy airspace to reach their targets;

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6. The largest group of very hard targets in the Soviet Union are about 800 newer missile silos for the SS-17, SS-18, and SS-19 ICBMs (older silos for the SS-11 and SS-13 ICBMs are probably only lightly hardened). The size of this group is not increasing and may decline as the Soviet Union replaces silo-based ICBMs with mobile ICBMs or retires silo-based ICBMs to meet some future negotiated cap on strategic warheads. For data on the hardness of Soviet missile sites see Robert Berman and John Baker, *Soviet Strategic Forces* (Washington, D.C.: Brookings Institution, 1982), p. 91; *Jane's Weapon Systems* (London, England: Jane's Publishing Company, 1985), p. 8; and *Aviation Week and Space Technology* (October 12, 1981), p. 22.

7. The sixth flight only utilized ten of the twelve available stations (nine Mark-4 RVs and one electronics pod).

8. Strategic weapons are not affected by the treaty on intermediate-range nuclear forces scheduled to be signed at a summit later this year. Limits on strategic weapons were discussed at the summit at Reykjavik in 1986 and are under discussion at the START negotiations, but no agreement has been reached.

- Air-launched cruise missiles (ALCMs) that, after being launched by strategic bombers outside enemy borders, fly into enemy airspace to attack targets;

- Sea-launched cruise missiles (SLCMs) that, after being launched from ships and submarines, fly into enemy airspace to attack targets; and

- Warheads on silo-based ICBMs, mobile ICBMs, and SLBMs.

Challenges will be faced in counting the warheads on each type of weapon. Some of the challenges include how to distinguish strategic bombers from other bombers; how to distinguish between bombers that carry ALCMs rather than bombs and SRAMs; whether to count the nuclear warheads that could be carried on "forward-based" bombers, such as U.S. F-111 bombers based in Europe; how to keep track of SLCMs and how to distinguish strategic nuclear SLCMs from either tactical SLCMs (which have shorter range) or SLCMs armed with conventional warheads; and how to find and count mobile ICBMs. Many ideas have been developed for dealing with these various challenges, but resolving them will probably be difficult.

This paper is concerned with an issue that bears on another challenge for counting strategic warheads: how to count the number of warheads on various ballistic missiles. This could be one of the most contentious challenges because, unlike warheads based on bombers or SLCMs, warheads on ballistic missiles can reach the other country quickly (in 15 to 30 minutes). This speed creates a risk that one country might be able to strike the weapons and command system of the other before it could prepare to respond. Both sides are concerned that a treaty not give the other country a significant advantage in the number of warheads deployed on ballistic missiles or an ability to break out--that is, to withdraw from the treaty and quickly place additional warheads on deployed missiles.

The difficulty in counting warheads on ballistic missiles, however, is that they are small and carried within the missiles, making it virtually impossible for one country to count the other's warheads directly. One convention for dealing with this problem is to credit each type of missile with a specific number of warheads, regardless of whether a particular missile carries fewer. The challenge is how to determine the number of warheads that should be credited to each missile type.

There are two basic approaches to this challenge. The first is to employ a counting rule to establish a baseline (see Box). For example, a missile might be credited with the maximum number of warheads it has

COUNTING RULES

Because warheads on ballistic missiles are carried inside the missiles, it is not possible to count them directly unless both sides agree to highly intrusive inspections. Even then, confidence in the resulting counts could only be maintained during and immediately after an inspection.

One alternative to counting warheads directly is to credit each type of missile with a specific number of warheads, regardless of whether an individual missile carries fewer. The question is, how should this specific number be chosen?

Several "counting rules" have been proposed. The three main approaches have been to credit a missile type with the maximum number of warheads released during a test flight, with the maximum number of warheads found during on-site inspections, or with the maximum number of warheads that it could potentially carry based on engineering measurements of missile size, fuel type, or the size and weight of the post-boost vehicle.

Many variations of these three basic approaches have been examined against three objectives: to represent accurately the number of warheads that are deployed; to decrease efforts to increase the number of deployed warheads surreptitiously; and to decrease the potential for "break-out"--withdrawing from a treaty and rapidly increasing the number of warheads on deployed missiles.

No single counting rule seems to attain all of these demanding and sometimes conflicting objectives. For example, flight tests are inadequate since some missiles might be deployed with more warheads than they have carried in tests. On-site inspections might make it difficult to increase the number of warheads on a given missile type surreptitiously, but they do not solve the problem of break-out. Engineering measurements might address break-out by evaluating the potential payload of a missile, but they overestimate the number of warheads deployed on some missiles.

Because of such problems, an alternative approach is under consideration: rather than relying on a single counting rule, the two powers would negotiate the number of warheads to assign to each missile type. They would then establish various collateral constraints to complicate any surreptitious deployment of additional warheads and to decrease the potential for break-out.

carried in flight tests or with the maximum number of warheads it is capable of carrying to a specified range based on calculations of the missile's throwweight. The second approach is to negotiate the number missile by missile.

Whichever approach is employed, the Administration's plans to flight-test both the eight-warhead and twelve-warhead versions of the Trident II might complicate the task of determining how many warheads to credit to the Trident II missile. 9/ If the United States should subsequently seek to deploy and credit the Trident II with only eight warheads (Option 1), the Soviet Union would probably argue that the missile should be credited with twelve warheads since the capability to carry twelve had been fully developed and demonstrated. If, on the other hand, the United States agreed to credit the Trident II with twelve warheads (Option 2), the United States would face several problems, possibly including increased risks to the survivability of U.S. missile-carrying submarines as well as an agreement that overcounted actual U.S. warheads. 10/

In light of these potential complications, critics have suggested a different path, which would be to cancel development of the twelve-warhead version of the Trident II immediately (Option 3). The hope is that by developing and deploying only the eight-warhead version of the Trident II, the United States would strengthen the groundwork for crediting the Trident II with eight warheads in a future agreement limiting strategic nuclear warheads.

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9. Flight tests have two important features. First, they offer the most realistic way of determining how a missile would perform in war; for that reason, engineers prefer to flight-test the missile in the same configuration that it will be deployed. Second, flight tests are the only ones that display components of the payload to the opponent. For these reasons, flight tests were employed as a collateral measure in the SALT II treaty. That treaty prohibited the deployment of more than a specific number of warheads on each type of missile. To help enforce this measure, each side was barred from conducting a flight test in which the sum of the number of RVs released and the number of maneuvers simulating the release of RVs exceeded the number of warheads permitted on the missile.

10. Another option would be to credit Trident II missiles with the number of warheads that are actually deployed. The eight-warhead version would be credited with eight warheads and the twelve-warhead version with twelve warheads. This option raises three problems. First, this option might require more complicated verification regimes since it could be very difficult for the Soviet Union to determine how many of each version had been deployed. Second, the option would leave the United States with the ability to break out, modifying the eight-warhead missiles into twelve-warhead missiles. Third, the option would set a precedent that might not serve U.S. interests. The United States, for example, would not want to credit some Soviet SS-18 ICBMs with one warhead (mod 1 and mod 3 of the SS-18 are believed to have only one warhead) when others might be deployed and credited with ten or more.

This paper focuses on the effect of these three options (summarized in Table 1) on U.S. policies, but the options could also affect the United Kingdom. The United Kingdom is planning to deploy Trident II missiles on four new submarines, the first of which was ordered in 1986 and is scheduled for deployment in the mid-1990s. It will develop and build its own nuclear warheads for the Trident II missiles, but the reentry vehicles carrying the warheads and the post-boost vehicles for deploying the reentry vehicles will probably be based on the designs developed and tested by the United States. 11/ If so, the United Kingdom would have the choice of employing either the eight-warhead Mark-5 version or the twelve-warhead Mark-4 version. If it were to choose the former, then none of the options in this paper would affect UK plans. If it were to employ both versions or the twelve-warhead version alone, however, then UK plans might be affected by the options set forth here. In any event, since the United Kingdom does not intend to deploy the Trident II missiles until the mid-1990s, it has time to adjust its plans according to changes in the U.S. program.

OPTION 1. PROCEED WITH TESTS BUT CREDIT TRIDENT II WITH ONLY EIGHT WARHEADS IN AN ARMS AGREEMENT

This option would proceed with all currently planned flight tests of the Trident II missile but would make deployment plans contingent on conclusion of an agreement limiting strategic warheads. In the absence of an agreement, the United States would proceed to deploy some of both the eight-warhead and twelve-warhead versions of the Trident II. The percentage of each version would depend on the hardness of the targets the warheads would be assigned to attack and other operational factors. During negotiation of an agreement limiting strategic warheads, however, the United States would offer to cancel the twelve-warhead version but insist on crediting the Trident II missile with only eight warheads.

Advantages

For reasons noted below, it might be difficult to persuade the Soviet Union to accept the second part of this option, which would credit the Trident II with only eight warheads under any future agreement limiting strategic nuclear warheads. But, if feasible, the option would offer several important advantages to the United States.

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11. By utilizing the U.S. design for the RVs and the post-boost vehicle, the United Kingdom could make use of U.S. flight-test data and avoid the cost and complications of testing a separate design.

TABLE 1. DESCRIPTION OF OPTIONS

Option	Testing Limits	Assumed Deployment Plan	U.S. Negotiating Strategy for Crediting Warheads to Trident II
1	No limits	Two tracks depending on arms limits - In absence of arms limits, deploy mix of 8-warhead and 12-warhead versions - In event of arms limits, deploy no more than 8 warheads	Credit with 8
2	No limits	One track - Deploy mix of 8-warhead and 12-warhead versions	Credit with 12
3	Limits	One track - Deploy 8-warhead versions only	Credit with 8

SOURCE: Congressional Budget Office.

One benefit is that this option would require no changes and, therefore, cause no delays in the current test program. The current test program has, according to the Navy, been designed by engineers to stress fully both the eight-warhead and twelve-warhead versions of the missile early in the flight-test program, providing information necessary for modifying the missile--which has already entered the early phases of production--at the earliest possible date. 12/

Another advantage would be that, if a treaty was not obtained, the United States would be able to utilize the full design capacity of the Trident II missile, deploying both the twelve-warhead Mark-4 version and the eight-warhead Mark-5 version of the missile. For any given level of Mark-4 RVs considered necessary to meet the requirements of U.S. nuclear doctrine in the absence of a treaty, deploying the twelve-warhead version would minimize expenditures by decreasing the number of missiles, and thus the number of Trident submarines, that would need to be deployed.

This option would also offer three advantages if there was an agreement and the United States chose to deploy only eight warheads on the Trident II:

- Deploying only eight warheads on Trident II missiles when there was a limit on strategic warheads would spread the warheads over a larger number of missiles and therefore over a larger number of submarines. Although this larger number of submarines would increase the costs of procurement and operation, the larger number would reduce the potential vulnerability associated with a smaller submarine force. 13/

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12. The Navy has procured 21 missiles in the 1987 budget and is requesting 66 missiles in the 1988 budget still under consideration by the Congress.

13. At the START negotiations, the United States has proposed a sublimit of 4,800 on ballistic missile warheads under a limit of 6,000 on strategic nuclear warheads. If, for example, under the sublimit of 4,800 the United States were to allocate 3,500 warheads to SLBMs, the United States could deploy eighteen Trident submarines if each missile was credited with eight warheads but only twelve Trident submarines if each missile was credited with twelve warheads (this example is just one of many plausible options). When only twelve Trident submarines are split between two oceans, with one to three in port at any given time on each coast for scheduled overhauls, repairs, or supplies, the Soviet Union might begin to perceive significant advantages in destroying a single Trident, since this would comprise a significant percentage of the entire deployed Trident force. With this incentive, the Soviet Union might increase efforts to trail the Tridents with attack submarines or to disable them through other tactics such as sabotage. The advantage of having a larger number of submarines, according to the U.S. Navy, is that it reduces the incentives for the Soviet Union to develop such capabilities.

- Deploying and crediting the Trident II with only eight warheads would avoid overcounting the U.S. inventory of ballistic missile warheads; if the Trident II missiles were credited with more than eight warheads, the missiles deployed in the eight-warhead Mark-5 version would be counted as carrying more warheads than they do.

- Although the twelve-warhead Mark-4 version (which carries smaller warheads than the eight-warhead Mark-5 version) of the missile would be canceled, the United States could still maintain the operational advantages inherent in deploying a mix of smaller warheads and larger warheads by developing a new post-boost vehicle designed to carry just eight of the smaller warheads rather than twelve.

Disadvantages

The major disadvantage of this approach is that it would be difficult to persuade the Soviet Union to agree to credit the Trident II with only eight warheads under a cap on strategic warheads. The Soviet Union would undoubtedly argue that since the United States had designed and fully tested the capability to deploy twelve warheads on the Trident II, it should be credited with that number. The United States might counter by offering on-site inspections or other collateral measures to strengthen Soviet confidence that the Trident II had been deployed with only eight warheads. Even such measures, however, would not decrease the established U.S. capability to break out--that is, to withdraw from the treaty and quickly increase the number of warheads deployed on the Trident II from eight to twelve. To decrease that risk, the Soviet Union would probably argue vigorously that the Trident II should be credited with twelve warheads.

This U.S. position might also complicate negotiations in another way. Since some Soviet missiles might have been deployed with more warheads than had been released in flight tests, the United States might find itself in the awkward position of arguing that the Trident II should be credited with fewer warheads than had been tested, while several Soviet missiles should be credited with more warheads than had been tested. 14/

It is conceivable that the Soviet Union would eventually agree to credit the Trident II with only eight warheads. Obtaining that agreement,

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14. During test flights, actual reentry vehicles are used but the nuclear warheads are replaced by dummy warheads having the same mass and center of gravity as actual warheads.

however, might well necessitate compromises on other issues. Working out such compromises would probably be a difficult and time-consuming process.

There are also other difficulties posed by Option 1. In the event of a treaty crediting the Trident II with only eight warheads, Option 1 could delay deployment of the Trident II with smaller warheads. That delay would stem from having to replace the twelve-warhead Mark-4 version with a new eight-warhead Mark-4 version. 15/ Flight tests would have to be conducted of the new version; also, if any missiles had been deployed with the twelve-warhead version (scheduled for initial operational capability in 1993-1994), they would have to be removed from Trident submarines and returned to naval facilities to be changed to either the eight-warhead Mark-5 version or the new eight-warhead Mark-4 version. 16/ The tasks of designing, testing, and deploying a new eight-warhead Mark-4 version would be time-consuming and would necessitate many accommodations in schedules for overhauls, port visits, and missile tests.

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15. Designing the new eight-warhead Mark-4 version could involve modifying the existing eight-station post-boost vehicle (PBV) for Mark-5 RVs, disabling four stations on the existing twelve-station PBV for Mark-4 RVs, or designing a new PBV from scratch. In any of these cases, flight tests would probably be required to make sure the new eight-warhead version would function as expected.

    Deployment of a Trident II missile with only eight Mark-4 RVs raises several points. First, since the payload would be lighter, the range of the missile would be greater, potentially increasing the area of the ocean where a host submarine could be deployed. This advantage, however, might not materialize since submarines deployed with some Trident II missiles with only eight Mark-4 RVs might also carry some Trident II missiles with eight Mark-5 RVs, constraining the distance the submarine could be deployed from its targets. Second, the greater payload of the missile could be employed to carry more penetration aids to defeat any emerging Soviet defenses. Third, the underutilization of the missile's potential payload might become a point of contention if the United States were to argue that certain Soviet missiles had payload that was underutilized and that should, as part of a guard against break-out, be limited.

16. Tests of the new eight-warhead Mark-4 version would probably be conducted with "DASO" test flights from new Trident submarines or from Trident submarines that have just completed a major overhaul (such tests are called "DASO" flights because they are conducted during sea trials referred to as demonstration and shakedown operations). If there were not enough DASO flights available for the test schedule, some operational test (OT) flights would probably be employed. The primary purpose of OT flights is normally to establish reliability and accuracy statistics used in modifying the Strategic Integrated Operational Plan (SIOP), the U.S. blueprint for conducting potential nuclear battles.

OPTION 2: PROCEED WITH TESTS AND CREDIT TRIDENT II WITH TWELVE WARHEADS IN AN ARMS AGREEMENT

Like Option 1, this option would proceed with all flight-testing, including tests of the twelve-warhead version of the Trident II missile. This option differs fundamentally from Option 1, however, in that the twelve-warhead version would not be canceled if a limit was negotiated on strategic nuclear warheads. Instead, the United States would plan on crediting the Trident II with twelve warheads.

This option would solve some of the arms control problems inherent in the first option but, as detailed below, it would create risks for U.S. submarines and raise the problem of "phantom" warheads--warheads that, although credited to the United States, did not exist. These problems could make it difficult for the United States to accept an arms agreement, or at least could necessitate changes in U.S. forces as a condition for acceptance.

Advantages

Options 1 and 2 would both fully support the test program planned by the Navy. But Option 2, by planning to credit the Trident II with twelve warheads under any future limit on strategic warheads, would place in concert U.S. flight-test plans, deployment plans in the absence of a treaty, and deployment plans in the event of a treaty. It would thus facilitate any future negotiations regarding strategic warheads. Since the United States would not be trying to credit the Trident II with fewer warheads than had been tested, the Soviet Union could not be expected to raise any substantive objections to the number of warheads credited to the Trident II.

In addition, by crediting the Trident II with the maximum number of warheads with which it had been tested and deployed, Option 2 would strengthen the U.S. case for crediting Soviet missiles with the maximum number of warheads deployed. It would avoid Option 1's awkward position of arguing that a U.S. missile should be credited with fewer warheads than tested while some Soviet missiles should be credited with more warheads than tested.

Finally, since U.S. testing and deployment plans in Option 2 would not be contingent on a treaty, the United States would have no need to develop and test a new version of the Trident II as in Option 1.

Disadvantages

While Option 2 would solve the arms control problems inherent in Option 1, it would introduce other disadvantages for the United States.

Risks to Submarines. Option 2 might endanger the survivability of U.S. missile-carrying submarines. By crediting the Trident II with twelve rather than eight warheads, fewer missiles and therefore fewer Trident submarines could be deployed for any given ceiling on strategic warheads. For example, the sublimit of 4,800 strategic ballistic missile warheads currently proposed by the United States at the START negotiations could result in a U.S. decision to deploy about 3,500 strategic warheads aboard SLBMs. 17/ If all Trident II missiles were credited with carrying twelve warheads, that decision would enable the United States to deploy only twelve Trident submarines (each Trident carries 24 missiles); whereas if each Trident II was credited with eight warheads, that decision would enable the United States to deploy 18 Trident submarines. 18/

The smaller number of missiles and submarines under this option might have the advantage of saving money on procurement and support of the submarines. 19/ But the smaller submarine fleet would also increase the risk that the Soviets would concentrate additional resources on threatening the smaller fleet, since the return on destroying each individual submarine would be higher. To eliminate this risk, the Navy might seek the development of a new, smaller ballistic missile submarine that would carry far fewer missiles, spreading a given number of missiles across a larger number of platforms. Developing a smaller submarine would, of course, be a very expensive undertaking. Another alternative would be to reduce the

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17. This example is just one of many plausible options. The United States could decide to allocate a higher or lower percentage of the sublimit to SLBMs with corresponding adjustments in the warheads allocated to ICBMs.

18. For comparison, today the United States has 36 missile-carrying submarines including 28 Poseidon submarines and 8 Trident submarines.

19. The United States is ordering its fifteenth Trident submarine in the fiscal year 1988 budget, which is still under consideration by the Congress, and the Administration has proposed procurement of the sixteenth in the fiscal year 1989 budget. Consequently, unless an agreement was reached and implemented promptly, the smaller number of submarines required under this option would not save a great deal of money on submarine procurement.

number of missiles on each Trident submarine, either by disabling some launch tubes or cutting a section out of the submarine. 20/

Phantom Warheads. Crediting each Trident II missile with twelve warheads would overcount the warheads deployed on each eight-warhead version of the Trident II. Therefore, the United States could not deploy as many warheads as permitted by a sublimit on ballistic missile warheads. The United States could address this problem of "phantom" warheads--warheads that although credited to the United States did not exist--in one of two ways. On the one hand, the United States could deploy only the twelve-warhead Mark-4 version of the Trident II missile. In this case, U.S. warheads would be counted accurately, but the United States would not have the capability against very hard targets that is provided by the eight-warhead version (only eight of the larger warheads fit on the Trident II). Establishing that capability has been a major objective of this Administration. 21/

On the other hand, the United States could deploy both versions of the missile, retaining the hard-target capability of the eight-warhead version. In this case, however, the United States would be unable to deploy as many warheads on ballistic missiles as permitted by a sublimit.

What affect would this have on the capability of the U.S. force? This paper presents two sample cases that represent plausible bounds on the number of phantom warheads. In both sample cases, it is assumed that there is a sublimit of 4,800 on ballistic missile warheads as proposed by the United States. 22/ Also, in accordance with Option 2, it is assumed that each

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20. Disabling launch tubes would probably include removing the support systems for the tubes (such as the gas ejection system and electronics), filling the tubes with concrete, removing the hatches, and welding the hull shut. This approach, however, would probably require the negotiation of detailed procedures to satisfy Soviet concerns and to satisfy U.S. concerns about similiar modification of Soviet submarines. The second approach of cutting out a section of the submarine would probably require more time and be much more expensive, albeit somewhat less expensive than building a new class of submarines.

21. The main theoretical argument for deploying the eight-warhead Mark-5 version of the Trident II is that deterrence is improved if the United States has a survivable capability to retaliate against the entire spectrum of facilities in the Soviet Union, including very hard targets. Other analysts disagree. For a discussion of the pros and cons of deploying hard-target capability on submarines, see Congressional Budget Office, *Trident II Missiles: Capability, Costs, and Alternatives* (July 1986), pp. 17-23.

22. If the sublimit was lower, the effect of phantom warheads might be correspondingly more significant since they might prevent the United States from retaining some desired minimum number of warheads on ballistic missiles.

Trident II is credited with carrying twelve warheads, even if it only has eight larger warheads.

In Sample Force 1, roughly 50 percent of the sublimit of 4,800 warheads is allocated to SLBMs, and 50 percent of the SLBMs is deployed with eight larger warheads rather than with twelve smaller warheads. The result is that the United States has 432 phantom warheads--that is, it has 432 fewer warheads than the 4,800 it is permitted and credited with having (see the Appendix for a complete description of the sample forces). 23/ This sample probably understates the number of phantom warheads the United States would actually have, since the United States is likely to allocate more warheads to SLBMs and possibly to deploy a higher percentage of Trident II missiles in the eight-warhead version.

In Sample Force 2, roughly 80 percent of the sublimit of 4,800 warheads is allocated to SLBMs, and 75 percent of the SLBMs is deployed in the eight-warhead rather than the twelve-warhead version. In this case, the United States has 936 phantom warheads.

Against large target sets, each phantom warhead represents one target that cannot be attacked. Even if target sets are small enough so that the phantom warheads do not decrease the number of targets attacked, they still decrease the number of warheads held in reserve.

Simply counting the phantom warheads, however, does not fully evaluate their significance. The capability of the sample forces depends on the yield and accuracy of the warheads as well as their number. To address these factors, this study assesses the capability of the sample forces to destroy notional target sets and compares their capability with that of forces that are identical except that the phantom warheads in each are replaced with actual warheads, bringing the number of actual warheads back to the sublimit of 4,800. 24/ The notional target sets in this analysis vary in size from 500 to 5,000 targets, and the targets vary in hardness from 100 to 5,000 pounds per square inch (psi). 25/ The Appendix shows all the

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23. In these cases, it is assumed that the United States has fully utilized the sublimit on ballistic missile warheads. The United States could also choose to deploy more than 1,200 warheads on other systems (bombers and possibly SLCMs), in which case the overall ceiling of 6,000 on strategic warheads would prevent the United States from fully utilizing the sublimit of 4,800 warheads on ballistic missiles.

24. The added warheads are those carried in Mark-5 RVs.

25. In these exchange models, several simplifying assumptions have been made (see the Appendix). These assumptions and the notional character of the target sets are designed to illustrate the potential effect of the phantom warheads, but they are not designed to provide an appraisal of the exact performance of U.S. forces in combat. Much more detailed scenarios are required for such appraisals.

results. Here, results of each sample force are presented against only two target sets: 5,000 lightly hardened (100 psi) targets and 5,000 very hard (5,000 psi) targets. 26/ Both target sets are very demanding in size, but the different levels of hardness illustrate the importance of yield and accuracy.

As expected, the results show that the sample forces do not do as well as their counterpart forces in which the phantoms have been replaced by hard-target warheads. But the differences are not large by some measures. For example, in the attack on very hard (5,000 psi) targets illustrated in Figure 2, Sample Force 1 never performs more than four percentage points worse than its counterpart force; Sample Force 2 never performs more than twelve percentage points worse than its counterpart.

Results do not differ markedly for attacks on lightly hardened targets (100 psi) as illustrated in Figure 3. Moreover, against smaller target sets the difference in performance between each sample force and its counterpart decreases (see Appendix). 27/

These results hold both under the assumption that the United States has not been attacked by the Soviet Union (the pre-attack case) and under the assumption that some U.S. forces would be destroyed by a Soviet attack and only remaining forces could retaliate (the post-attack case). Indeed in the post-attack case, differences between sample forces and their counterparts never exceed ten percentage points.

Two conclusions can be drawn from this analysis. Against large target sets, the phantom warheads would diminish performance; some facilities that would otherwise have been attacked would not be. On the other hand, given the large destructive capability still presented by the sample forces,

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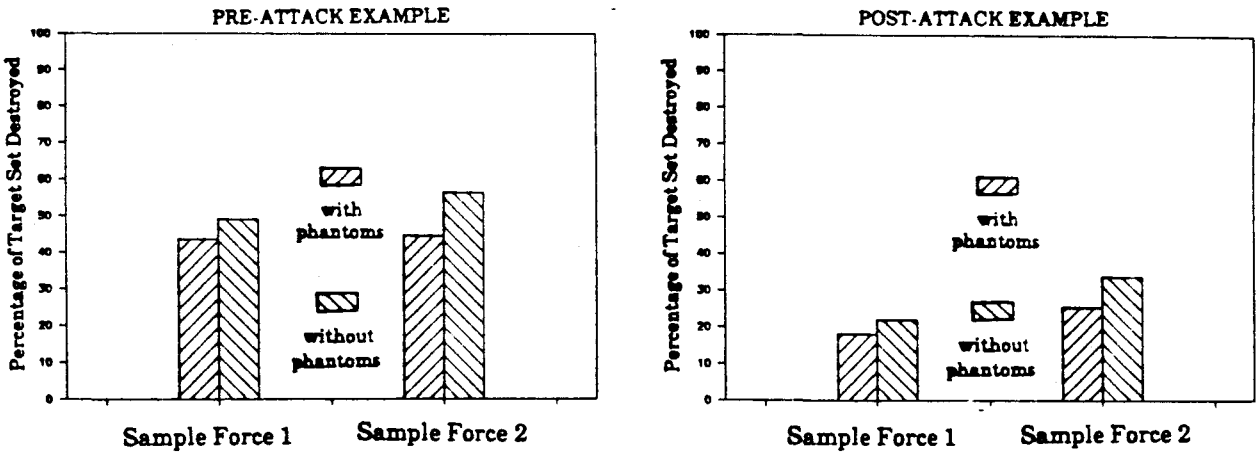
26. The hardness of a target is measured by its ability to withstand a high-pressure shock wave generated by a nuclear blast. For example, a target hardened to 100 psi has 50 percent probability of withstanding a shock wave with a pressure of 100 psi without suffering major structural damage.

27. The differences would be even smaller if the capability of U.S. strategic bombers was included in these exchanges. The cruise missiles, bombs, and short-range attack missiles carried by bombers are a good substitute for warheads on ballistic missiles against many targets. But if the targets must be destroyed quickly (as might be the case, for example, if they were mobile, but the current location was known, or if the objective was to destroy the targets before they could contribute to an attack on the United States), then weapons carried by bombers are not a good substitute because of the longer time (many hours versus 15 to 30 minutes) required for delivering the weapons to their targets.

FIGURE 2. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 5,000 HIGHLY HARDENED (5,000 PSI) TARGETS

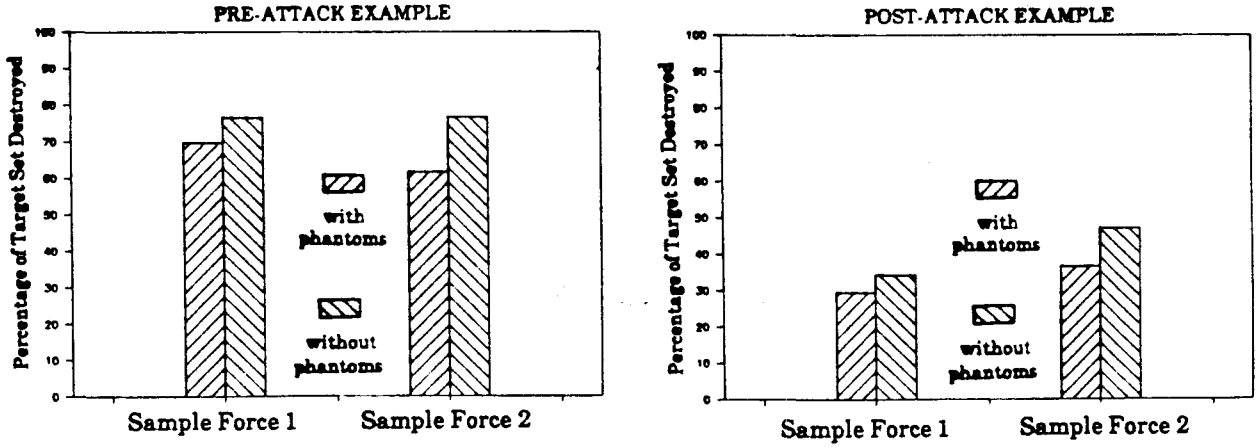


SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.

See the Appendix for a detailed description of the sample forces and of the assumptions employed in the exchange model.

FIGURE 3. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 5,000 LIGHTLY HARDENED (100 PSI) TARGETS



SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.

See the Appendix for a detailed description of the sample forces and of the assumptions employed in the exchange model.

the modest changes in performance caused by the phantom warheads would appear to have little effect on deterrence. 28/

Thus, the political significance of phantom warheads might be more important than the military significance. On political grounds, it could be very difficult for the United States to accept an arms control treaty that provided an "equal" ceiling but in practice enabled the Soviet Union to deploy more warheads on ballistic missiles than the United States. 29/

As was the case with the Soviet Union under Option 1, the United States might eventually accept an arms agreement crediting the Trident II with twelve warheads even if some carried only eight warheads. Acceptance might, however, require concessions from the Soviet Union that would be difficult to negotiate. Alternatively, acceptance could require changes in U.S. forces. The United States might want to develop a smaller missile-carrying submarine to avoid the risk of decreased survivability or deploy fewer of the eight-warhead Mark-5 version of the Trident II missile, decreasing the number of phantom warheads. Such changes could be controversial, time-consuming, and costly, complicating the process of negotiating an agreement capping strategic nuclear warheads.

OPTION 3. CANCEL TESTS OF THE TWELVE-WARHEAD VERSION AND CREDIT TRIDENT II WITH EIGHT WARHEADS

This option would cancel any further testing and development of the twelve-warhead version of the Trident II missile in hopes of minimizing complications in future arms negotiations. The expectation would be that, by developing and deploying the missile with no more than eight warheads, the United States would strengthen the case for crediting the Trident II with only eight warheads under any future agreement limiting strategic nuclear warheads. This should avoid the negotiating problems likely in Options 1 and 2.

A variant of this option, also discussed below, would continue testing the twelve-warhead version of the missile but would prohibit it from carrying more than eight warheads on a flight test.

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28. One way to put the changes induced by phantoms into perspective is to note that changes of that magnitude or more could, if deemed important to deterrence, be achieved by putting more U.S. warheads on submarines with a higher probability of surviving a Soviet attack. Note that Sample Force 2, with 936 phantom warheads but more actual warheads on submarines, in most cases does a better job of destroying 5,000 targets following a Soviet attack than does Sample Force 1, which has only 432 phantom warheads but fewer actual warheads on submarines.

29. It is possible that the Soviet Union would also choose to deploy its forces in a configuration that would result in phantom warheads.

Feasibility of the Option

Some analysts might argue that this option is infeasible. The United States has already conducted one flight test of the twelve-warhead version of the Trident II, and another test is apparently imminent. Thus, the Soviet Union can contend that the United States has already established the ability to deploy the Trident II with twelve warheads and that the Trident II should therefore be credited at that level. Underlying this viewpoint is the belief that, given advanced computer modeling and the U.S. Navy's long experience in designing SLBMs, only a few flight tests would be necessary before deploying the twelve-warhead version with confidence that it would perform as expected.

While there is merit to this argument, it is also arguable that prohibiting further testing of the twelve-warhead version, as called for by this option, would give the United States good grounds for contending that the Trident II should be credited with only eight warheads. First, at most two tests would have been conducted early in the Trident II development program (the sixth and eighth flights in the 30-flight development program). The final deployed Trident II missiles would probably have many small but significant differences from the development missiles, reducing the relevance of the one or two flight tests. Second, since the test or tests would have been conducted over a short period of time, they would not have provided the opportunity to digest the data from the tests, modify the twelve-station post-boost vehicle on the basis of that data, and test the modifications. Such a process is essential for developing a mature, reliable design. Third, the twelve-warhead version is not scheduled for deployment until 1993-1994; if additional flight tests with the Mark-4 post-boost vehicle are canceled now, that six-year to seven-year period might reduce the relevance of data from the one or two flight tests conducted of the twelve-warhead version. 30/ Finally, if the second flight test of the twelve-warhead version is canceled, that version will never have been tested with a full complement of warheads (on the first test of this version, only ten of the twelve stations were utilized).

This study cannot resolve these arguments and determine whether canceling further tests of the twelve-warhead version will persuade the Soviet Union to agree quickly to credit the Trident II with only eight warheads. It is clear, however, that a significant number of additional tests would make it exceedingly difficult to argue that the Trident II does not have a fully developed capability to carry twelve warheads; conceding that

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30. There is a precedent for counting the Trident II with eight warheads despite one or two tests of the twelve-warhead version. The Minuteman III was tested with seven warheads, but in SALT II the Soviet Union recognized that it had been deployed with only three warheads. See Article IV, Clause 10, First Agreed Statement and Common Understanding.

capability would complicate U.S. efforts to credit the missile with only eight warheads. If the Congress is to pursue limits on testing of the twelve-warhead Mark-4 version, it should do so as soon as possible to minimize the number of such tests.

Advantages

The main potential advantage of Option 3 is, as discussed above, that it would strengthen U.S. efforts to negotiate crediting the Trident II missile with only eight warheads. In addition, Option 3 might facilitate potential U.S. efforts to credit some Soviet missiles with the larger number of warheads that might be deployed on them rather than with the smaller number of warheads actually tested. The basis for this expectation is that the United States would be removed from the awkward position of arguing to credit some Soviet missiles with more warheads than have been tested while insisting on crediting a U.S. missile with fewer warheads than have been extensively tested.

Compared with Option 2, this option also means that more missiles--and therefore more missile-carrying submarines--would be deployed under any given cap on ballistic missile warheads. Although more submarines would increase costs for procurement, operation, and maintenance, they would reduce concerns that the Soviet Union might find ways to trail or otherwise attack a smaller fleet.

Nor would this option foreclose some future deployment of the smaller and cheaper (since they have already been built) Mark-4 RVs on the Trident II. One option would be to resume testing and deployment of the twelve-warhead version in the absence of an agreement prohibiting that decision. It would be somewhat more complicated and would incur some additional costs, however, to conduct such tests in the future rather than during the currently planned development program. 31/

Perhaps the most promising option for future deployment of the smaller and cheaper Mark-4 RV, however, is the development of a new post-boost vehicle for the Trident II that would carry only eight Mark-4 RVs. 32/

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31. Also, under a future treaty the option of resuming development of the twelve-warhead version of the missile might reduce Soviet incentive for break-out since the United States could, following necessary tests, respond by increasing the warheads deployed on the Trident II.

32. Other long-term options include deploying all Trident II missiles with Mark-5 RVs or keeping some Trident submarines deployed with Trident I missiles--which already carry eight Mark-4 RVs--rather than refitting them with Trident II missiles.

This approach combines some of the best features of Options 1 and 3. It facilitates the negotiation of an arms control agreement while preserving the flexibility inherent in deploying both the Mark-4 (which causes less collateral damage when used against targets close to cities) and the Mark-5 (which has better capability to destroy very hard ICBM silos and command centers buried deep underground).

Disadvantages

The key disadvantage of Option 3 is that it could disrupt the flight-test program for the Trident II, though probably only modestly. The eighth test, if it has not occurred, would have to be canceled; it would be too late to reconfigure the test with an eight-warhead version of the missile. This could delay the program, but the delay would be minimal since a test is scheduled every four to six weeks. In addition, if at some later date a decision was made to resume development of the twelve-warhead version, it might not be possible to deploy that version according to the original schedule. Since initial deployment is not scheduled until 1993-1994, however, no delay would occur if the decision to resume development was made by 1990.

Option 3 could also add to costs. If the United States decided to deploy smaller Mark-4 RVs on a new eight-warhead post-boost vehicle, 50 percent more missiles and missile-carrying submarines would be needed to deploy any given number of them than would be required on the twelve-warhead Mark-4 version currently under development. This would impose substantial costs, but the comparison is only relevant under two assumptions: that in the long term the United States would not succeed in negotiating a limit on strategic warheads; and that the United States would seek to deploy as many of the smaller warheads on the new eight-warhead Mark-4 version as it would have deployed on the twelve-warhead version.

How to Impose Testing Limits

The approach presented by Option 3 would cancel all further flight tests of the twelve-warhead Mark-4 version of the Trident II. Another approach would permit continued flight tests of the twelve-warhead Mark-4 version but allow it to carry no more than eight warheads on any flight test. This would have the advantage of minimizing interference with the current test program and, seemingly, strengthening the U.S. case for crediting the Trident II with only eight warheads under a limit on strategic warheads.

It might not accomplish this objective, however. If the United States continued to flight-test the twelve-warhead version, those tests would enable it to develop a mature system for carrying twelve warheads even if each individual flight carried no more than eight warheads. This is true because the development missiles used in future flight tests would begin to resemble production missiles; because there would be the opportunity to observe problems, design corrections, and test the modifications; and because each of the twelve warhead stations could be tested on various test flights. In combination with computer modeling, this should provide confidence that the twelve-warhead version would work correctly, even if all twelve warheads were never tested on a single flight test. Therefore, this variant probably would not have the desired effect of strengthening the U.S. case for crediting the Trident II with only eight warheads under a limit on strategic warheads.

This variant would also open the United States to the charge that it was deliberately undertesting the capability of the Trident II. That would be an uncomfortable position, since the United States has encouraged the Soviet Union to test the full capability of its missiles.

In short, merely limiting further flight tests of Trident II missiles to no more than eight warheads might not simplify arms control negotiations. If the Congress decides to limit Trident II testing, it should consider prohibiting tests of any post-boost vehicles designed to carry more than eight warheads.

CONCLUSION

The task of determining how many warheads to credit to each type of ballistic missile is only one of several difficult tasks that negotiators must tackle to reach agreement on a treaty limiting strategic nuclear warheads. Even so, it might be one of the more contentious tasks because both sides seek to ensure that a treaty does not give the other side an advantage in ballistic missile warheads, which are considered the most threatening of strategic weapons.

The United States must therefore decide whether to proceed with plans to develop and deploy a twelve-warhead as well as an eight-warhead version of the Trident II missile.

This paper has presented three options, each of which offers advantages and disadvantages (see Table 2). The first two, which do not limit testing and development of the twelve-warhead version, would avoid

TABLE 2. SUMMARY OF KEY ADVANTAGES AND DISADVANTAGES

Option	Description	Key Advantages	Key Disadvantages
1	- No testing limits - Deploy with up to 12 warheads in absence of agreement - Deploy and credit with 8 warheads under an agreement	- No changes in test program	- Hard to get Soviet Union to accept
2	- No testing limits - Deploy with up to 12 warheads - Credit with 12 warheads under an agreement	- No changes in test program	- U.S. might have trouble accepting or would require force changes
3	- Testing limits - Test and deploy with no more than 8 warheads - Credit with 8 warheads under an agreement	- Would facilitate arms negotiations	- Limits beyond 1990 could delay future 12-warhead version

SOURCE: Congressional Budget Office.

any disruption in current test plans and provide a tested capability to match deployments to any future operational requirements. But both options could complicate future arms negotiations. The Soviet Union might have trouble accepting Option 1, which would credit the United States with eight warheads on the Trident II missile despite a fully tested capability to carry twelve; the United States might have trouble accepting Option 2, which would create phantom warheads and might increase the vulnerability of missile-carrying submarines.

Option 3, which would limit testing of the twelve-warhead version, would modestly disrupt the current test plan and could add to future costs under certain circumstances. Its key advantage is that it should facilitate negotiations of a limit on strategic nuclear warheads.

APPENDIX EFFECTS OF PHANTOM WARHEADS ON CAPABILITY OF U.S. STRATEGIC BALLISTIC MISSILE FORCE

In Option 2 of this paper, each Trident II missile would be credited under a limit on strategic warheads with twelve warheads even if it only carried eight of the larger warheads contained in Mark-5 reentry vehicles (only eight will fit on the missile).

Thus, the U.S. ballistic missile force would contain "phantom" warheads--that is, warheads credited to the United States that would not actually exist. In this paper, two sample ballistic missile forces are analyzed to illustrate the potential effect of these phantom warheads. This Appendix provides details regarding that analysis, including the methodology employed in the nuclear exchange model, the detailed composition of the sample forces, and the results of exercising the sample forces against notional target sets that vary in size and hardness.

METHODOLOGY

Several simplifying assumptions are employed in determining how many of each notional target set are destroyed by each sample force: the reliability (the probability that a missile will deliver a warhead to the target area and that the warhead will detonate) of each missile is 80 percent; no more than two warheads are used against each target; the exchange model allocates the warheads in a manner that maximizes the number of targets destroyed; and the command system functions perfectly. Also, the model only evaluates the capability of the ballistic missile force; other strategic weapons including bomber-delivered munitions (bombs, short-range attack missiles, and air-launched cruise missiles) and sea-launched cruise missiles are not included.

The probability that each arriving warhead will destroy a target is calculated from a formula presented by Lynn Davis and Warner Schilling in the article "All You Ever Wanted To Know About MIRV and ICBM Calculations But Were Not Cleared To Ask." 1/ The assumptions for the

1. *Journal of Conflict Resolution*, vol. XVII, no. 2 (June 1973).

yield and accuracy of each warhead are drawn from a study by the Congressional Budget Office titled Trident II Missiles: Capability, Costs, and Alternatives (July 1986). 2/

The study looks at both a pre-attack case and a post-attack case. In the pre-attack case (a scenario in which the United States employs its weapons before the Soviet Union attacks them), weapon availability is 100 percent. In the post-attack case (a scenario in which the Soviet Union has attacked the U.S. forces with the intent of destroying as many as possible), it is assumed that all U.S. silo-based ICBMs are destroyed and 30 percent of all U.S. SLBMs and mobile-ICBMs are destroyed.

In each exercise, the capability of both sample forces are evaluated and compared to the capability of counterpart forces in which each phantom warhead in the sample forces has been replaced by the warhead carried in a Mark-5 reentry vehicle.

The simplifying assumptions in this nuclear exchange model and the notional character of the target sets are designed to illustrate the potential effect of the phantom warheads on the capability of the U.S. ballistic missile force, but they are not designed to produce an appraisal of the probable performance of U.S. forces in combat. Much more detailed scenarios and assumptions are required for such appraisals.

COMPOSITION OF THE SAMPLE FORCES

The composition of the sample forces is based on a sublimit of 4,800 warheads on ballistic missiles. This is the sublimit currently proposed by the United States at the Strategic Arms Reduction Talks (START) in Geneva. It is assumed that each Minuteman III missile is credited with three warheads; that each MX missile is credited with ten warheads; that each Small ICBM (SICBM) is credited with one warhead; and that each Trident II is credited with twelve warheads. Each missile, except the Trident II, is assumed to carry the number of warheads credited to it. The Trident II comes in two versions, one carrying twelve smaller warheads and one carrying eight larger warheads.

The two sample forces represent plausible bounds on the number of phantom warheads. In Sample Force 1, it is assumed that the United States has chosen to allocate roughly 50 percent of the sublimit on ballistic missile

2. p. 10.

warheads to SLBMs and to deploy 50 percent of the SLBMs in the eight-warhead version. The result is that there are 432 phantom warheads in the U.S. force--that is, there are 432 more warheads credited to the U.S. force than actually deployed (see chart labeled "Composition of Sample Force 1"). In Sample Force 2, it is assumed that the United States has chosen to allocate roughly 80 percent of the sublimit to SLBMs and to deploy 75 percent of the SLBMs in the eight-warhead version. The result is that there are 936 phantom warheads (see chart labeled "Composition of Sample Force 2").

COMPOSITION OF SAMPLE FORCE 1

	Missiles	Deployed Warheads	Credited Warheads
Minuteman III ICBMs (Mk-12 RVs)	102	306	306
Minuteman III ICBMs (Mk-12A RVs)	300	900	900
Silo-based MX ICBMs (Mk-21 RVs)	50	500	500
Mobile MX ICBMs or SICBMs (Mk-21 RVs)	50 or 500	500	500
Trident II SLBMs (12 Mk-4 RVs)	108	1,296	1,296
Trident II SLBMs (8 Mk-5 RVs)	108	864	1,296
Total		4,366	4,798

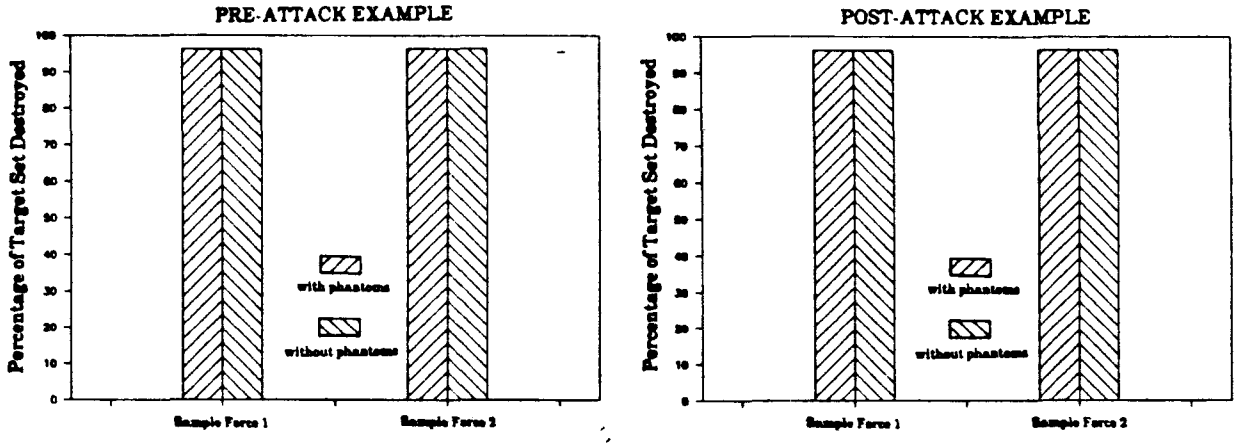
COMPOSITION OF SAMPLE FORCE 2

	Missiles	Deployed Warheads	Credited Warheads
Minuteman III ICBMs (Mk-12 RVs)	0	0	0
Minuteman III ICBMs (Mk-12A RVs)	18	54	54
Silo-based MX ICBMs (Mk-21 RVs)	50	500	500
Mobile MX ICBMs or SICBMs (Mk-21 RVs)	50 or 500	500	500
Trident II SLBMs (12 Mk-4 RVs)	78	936	936
Trident II SLBMs (8 Mk-5 RVs)	234	1,872	2,808
Total		3,862	4,798

EXERCISES

Each sample force was exercised against various notional target sets that varied in size and hardness. This Appendix presents the results of exercises against a small target set in Figure A-1 (500 lightly hardened targets) and Figure A-2 (500 highly hardened targets); against a medium target set in Figure A-3 (2,000 lightly hardened targets) and Figure A-4 (2,000 highly hardened targets); and against a large target set in Figure A-5 (5,000 lightly hardened targets) and Figure A-6 (5,000 highly hardened targets). Each figure shows both the pre-attack and the post-attack case.

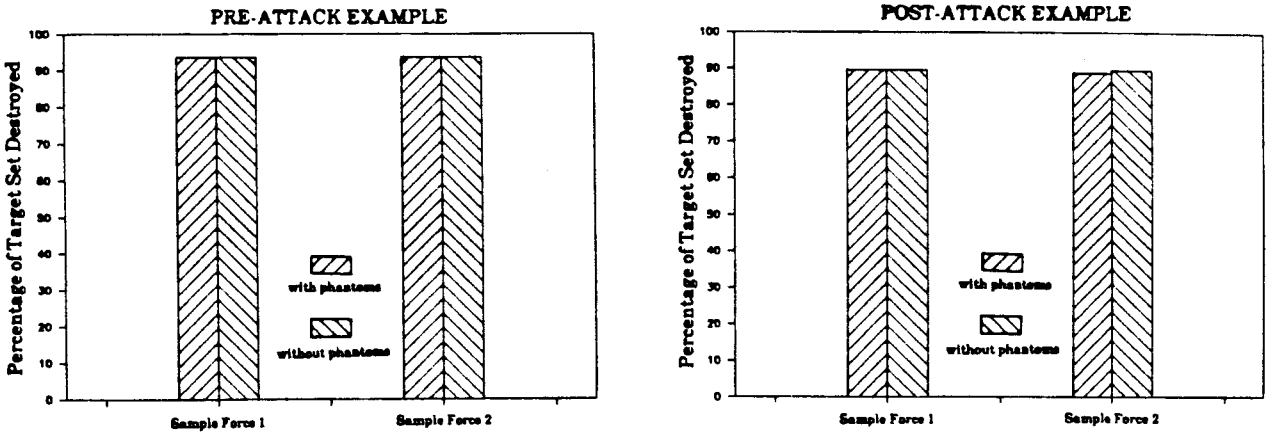
FIGURE A-1. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 500 LIGHTLY HARDENED TARGETS



SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.

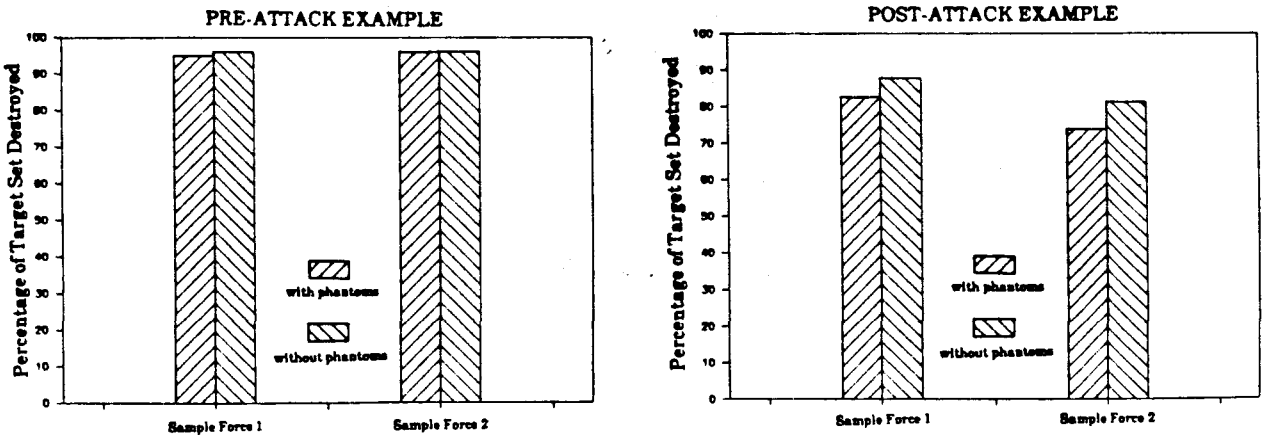
FIGURE A-2. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 500 HIGHLY HARDENED TARGETS



SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.

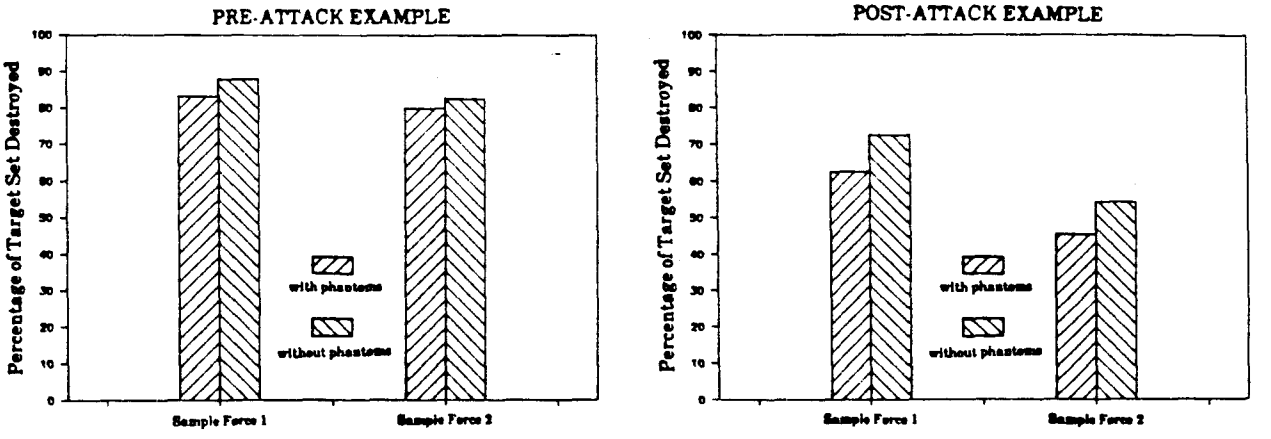
FIGURE A-3. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 2,000 LIGHTLY HARDENED TARGETS



SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.

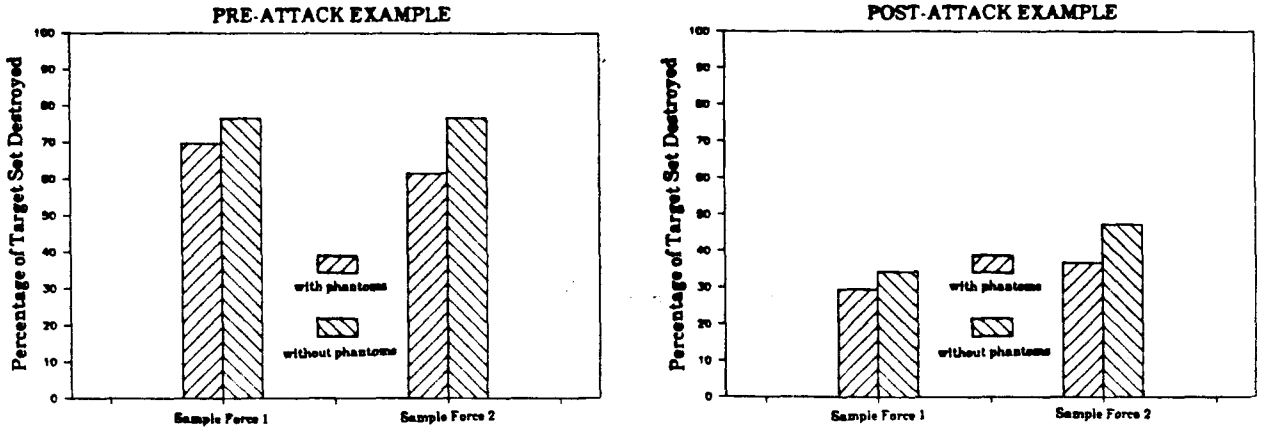
FIGURE A-4. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 2,000 HIGHLY HARDENED TARGETS



SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.

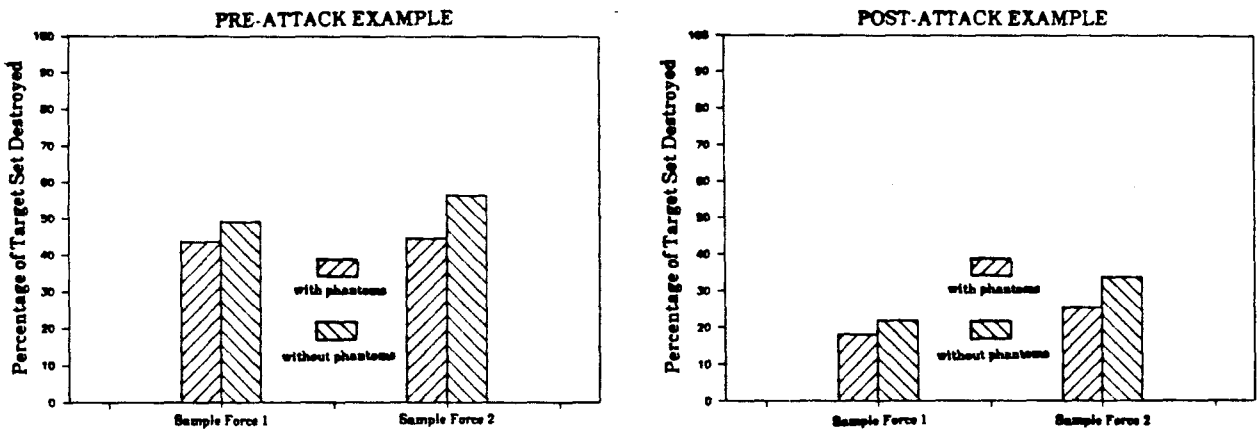
FIGURE A-5. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 5,000 LIGHTLY HARDENED TARGETS



SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.

FIGURE A-6. EFFECT OF PHANTOM WARHEADS ON CAPABILITY OF SAMPLE FORCES TO DESTROY 5,000 HIGHLY HARDENED TARGETS



SOURCE: Calculations by Congressional Budget Office.

NOTES: The results displayed in the column marked "without phantoms" show the effect of replacing each phantom warhead in the sample force with a warhead contained in a Mark-5 reentry vehicle.